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MEMORANDUM FOR PRS (In-House Publication)

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SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-AB-2001-231**
Wolfgang Schall, et al., Frank Mead et al., "Comparative Lightcraft Impulse Measurements"

Laser Ablation 2002 **(Statement A)**
(Taos, NM, 21 April 2002) **(Deadline: PAST DUE)**

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PHILIP A. KESSEL Date
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Title: Comparative Lightcraft Impulse Measurements

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Abstract

The impulse coupling coefficients, c_m, of two radically different laser propulsion thruster concepts (lightcrafts), each 10 cm in diameter, have been measured under equal conditions using two different test stands. Lightcraft one is of toroidal shape and was provided by the U.S. Air Force Research Laboratory (AFRL). A lightcraft of this shape and size has been used in free flight experiments at White Sands Missile Range, NM. Lightcraft two is bell (e.g., a paraboloid) shaped. With this type of lightcraft, the DLR previously conducted preliminary performance experiments, including vertical wire-bound flights in the laboratory. Both test stands were of the pendulum type. Test stand one was provided by the AFRL, and was a "rigid" pendulum, allowing motion in only one degree of freedom. The second test stand, a DLR design, suspended the lightcraft by thin wires and corresponded to a nearly perfect pendulum in the mathematical sense. All experiments employed the DLR electric-beam sustained, pulsed, CO_2 laser with pulse energies up to 400 J. The laser was operated with two configurations: 1) a stable resonator (flat beam profile); and, 2) an unstable resonator (ring shaped beam profile). All experiments were carried out in the open laboratory environment. Propellant, therefore, was either the surrounding air alone, or Delrin as an added solid propellant. For lightcraft one the c_m value increased by a factor of three (450 N/MW) by adding Delrin. With lightcraft two, a comparable c_m value of 590 N/MW was obtained. This corresponded to a Delrin loss of 60-80 μg/J. Results of c_m as a function of the laser pulse energy for the various experimental conditions will be presented.
Currently, experiments are under preparation for the measurement of c_m and the propellant consumption when the two lightcrafts are operated in a vacuum chamber with solid fuel under reduced pressures as low as 10^{-3} bar. These measurements are relevant for launching vehicles into space as they transition

from endo- to exoatmospheric flight. The results of these vacuum experiments will also be presented.

This work has been kindly supported by contract through AFRL/EOARD.

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